

Um Universo de Galáxias

Como estudamos a nossa e outras galáxias hoje?

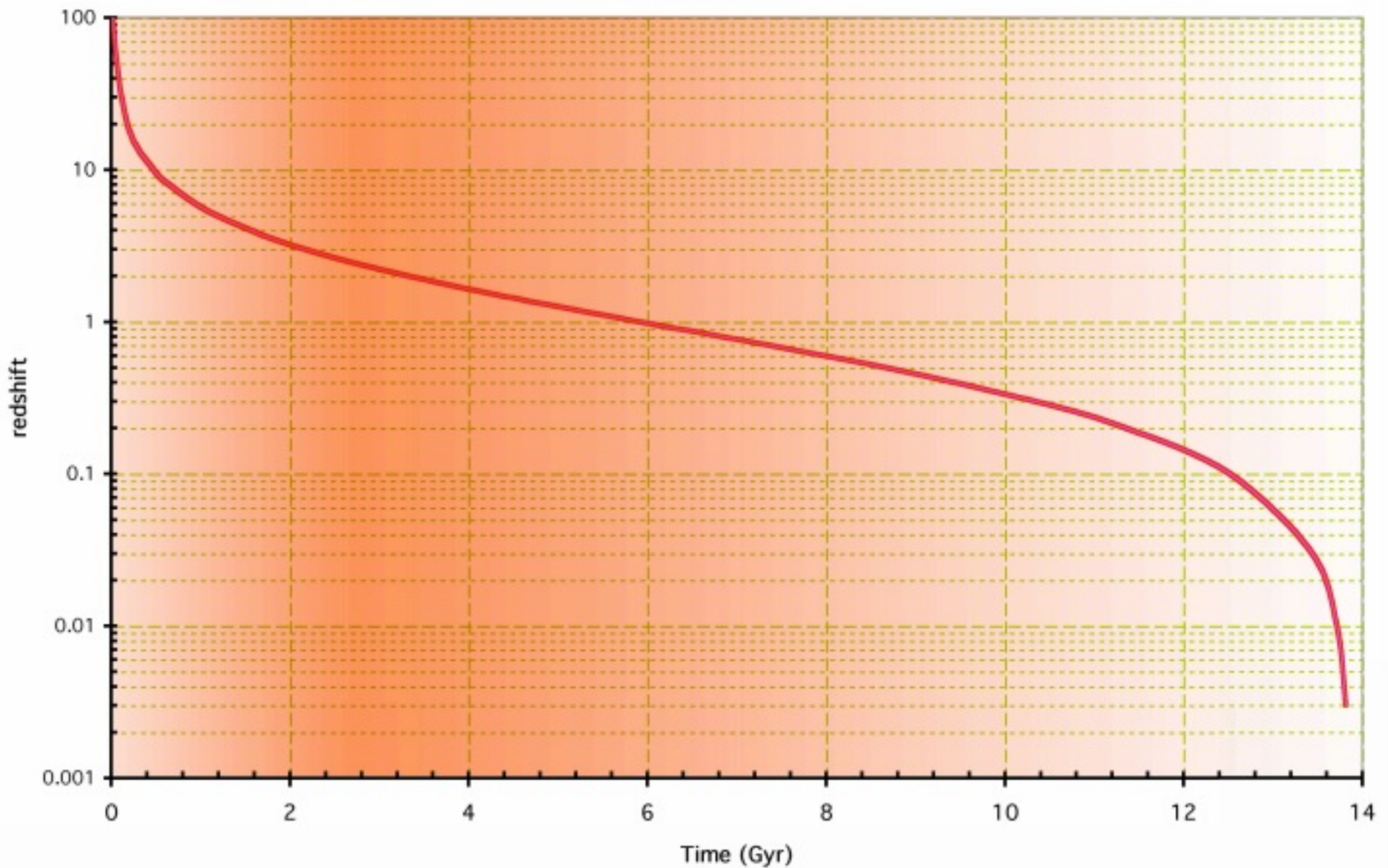


Um Universo de
Estrelas e Galáxias

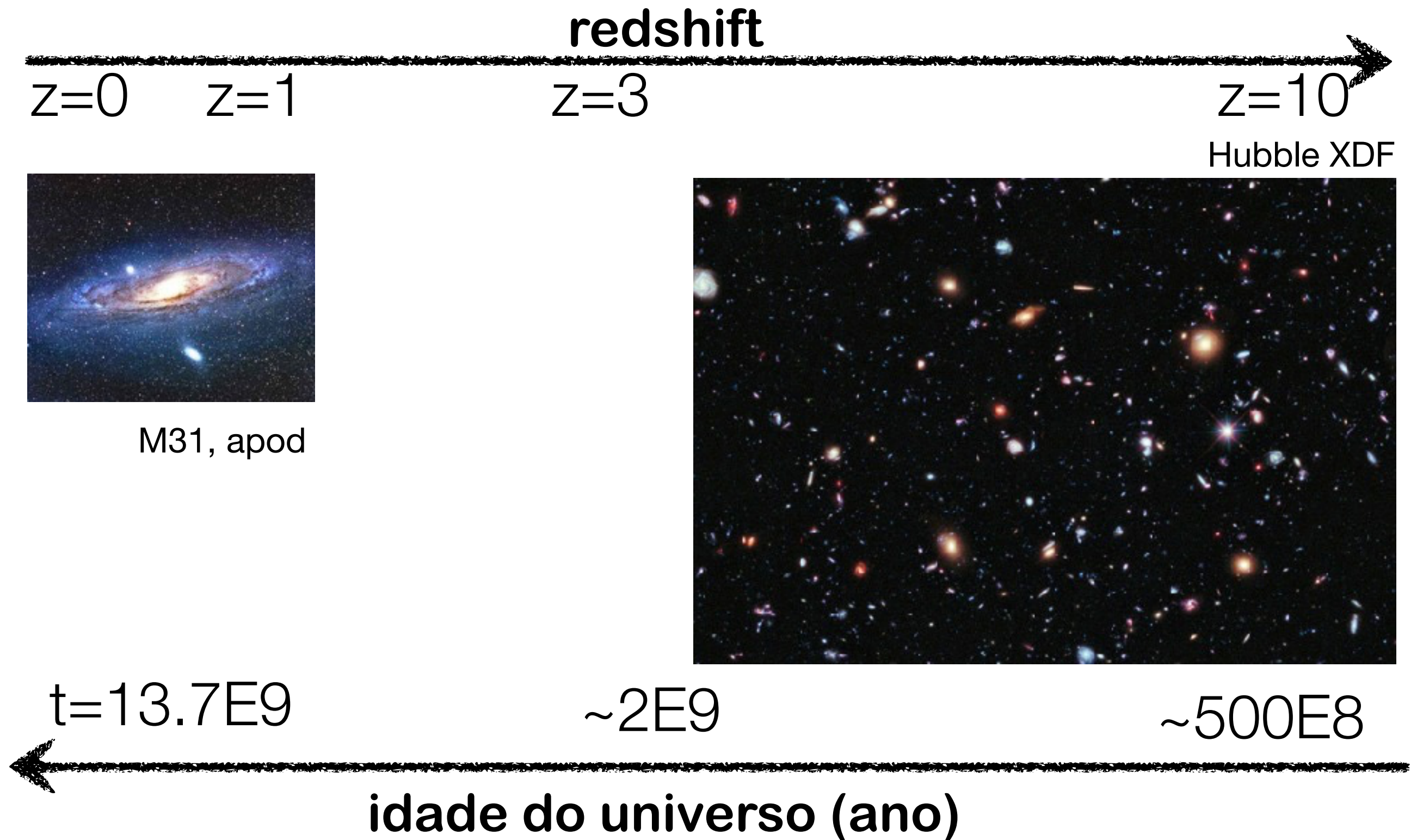
Como estudamos a nossa e outras galáxias hoje?

"Lookback time" versus Arqueologia

$H_0 = 68 \text{ km/s/Mpc}$, $\Omega_m = 0.3$, $\Omega_{\Lambda} = 0.7$



Estudando as galáxias com lookback time



Arqueologia

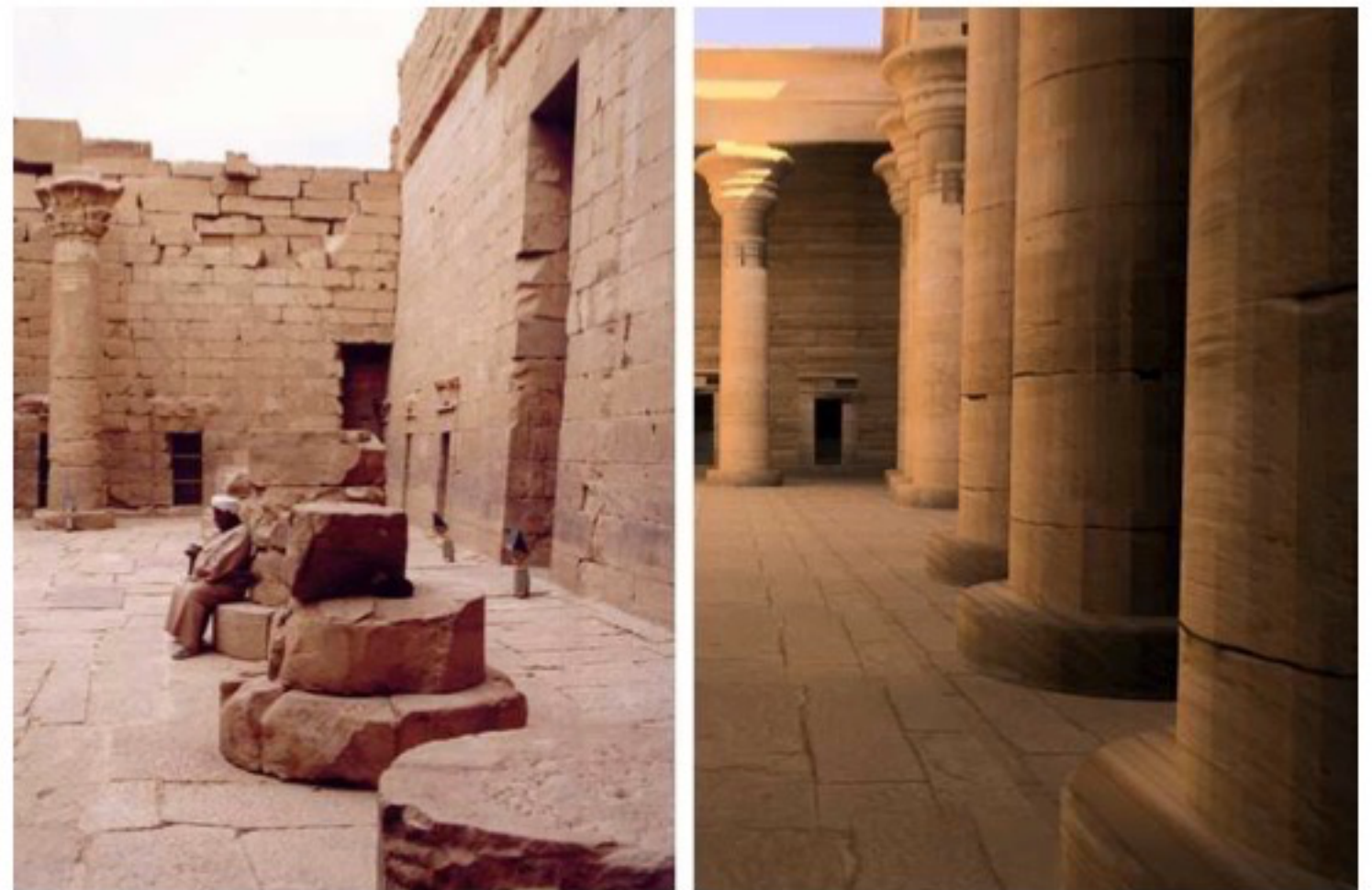


Figure 9: (a) View of the courtyard today and (b) how it may have appeared in 30BC.

Credit: High Fidelity Reconstruction of the Ancient Egyptian Temple of Kalabsha, Sundstedt, Chalmers & Martinez (2004)

Nosso sítio arqueológico:

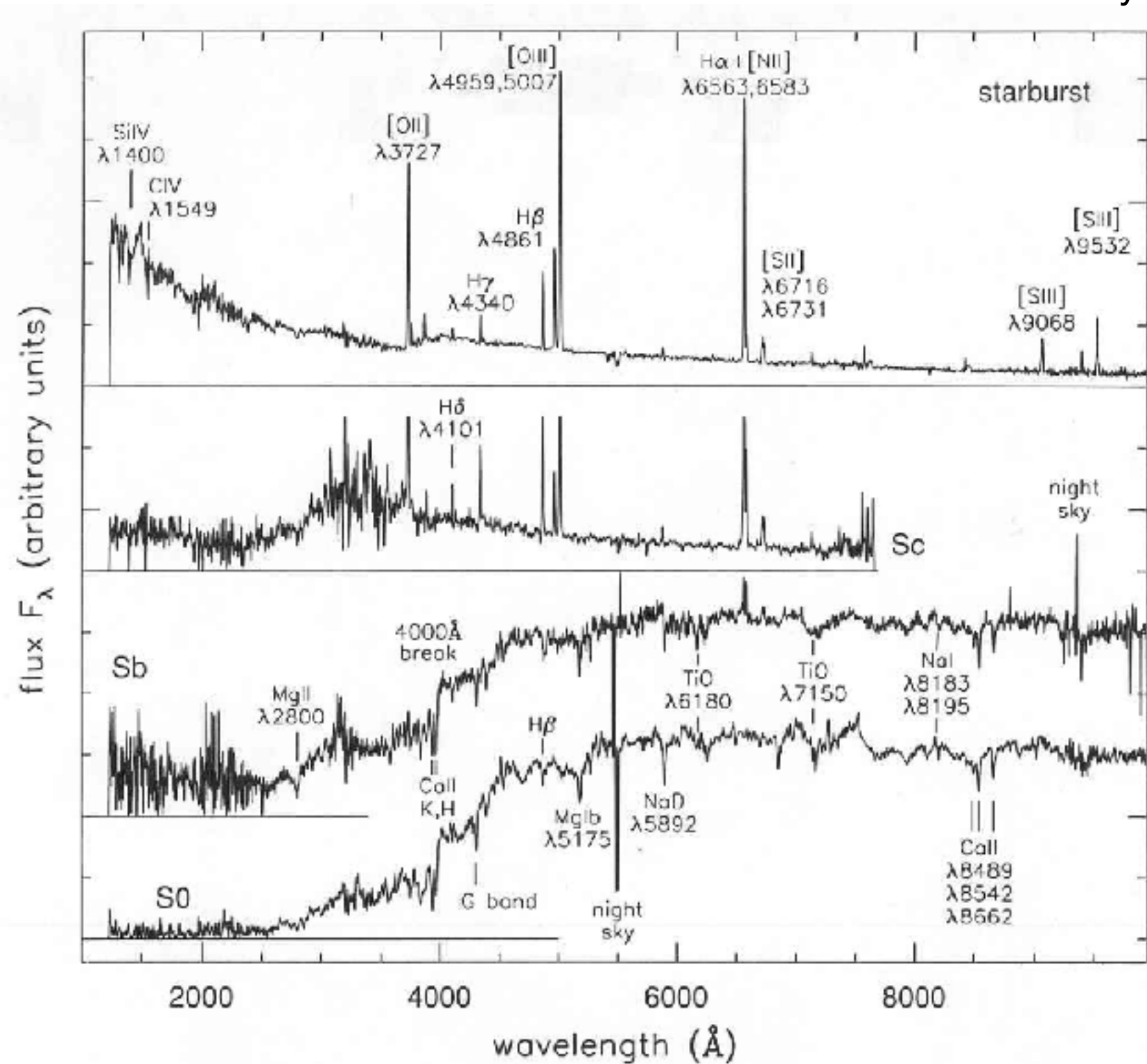
Assinaturas observacionais em estrelas
e galáxias próximas

Estudando a nossa e outras galáxias

- Fotometria: número de objetos observados é ordens de grandeza maior (~1 bilhão de detecções de imageamento no SDSS DR13 vs. ~4 milhões de espectros; <http://www.sdss.org/dr13/scope/>)
- Espectroscopia: a mais usada em estudos de arqueologia da Galáxia
- Multispectral imaging (e.g. J-PAS)
- Cubo de dados (e.g. MUSE)
- Contagem de fótons (e.g. Altas energias...)

Assinaturas em espectros de galáxias

Credit: A. Kinney



Assinaturas em espectros de estrelas

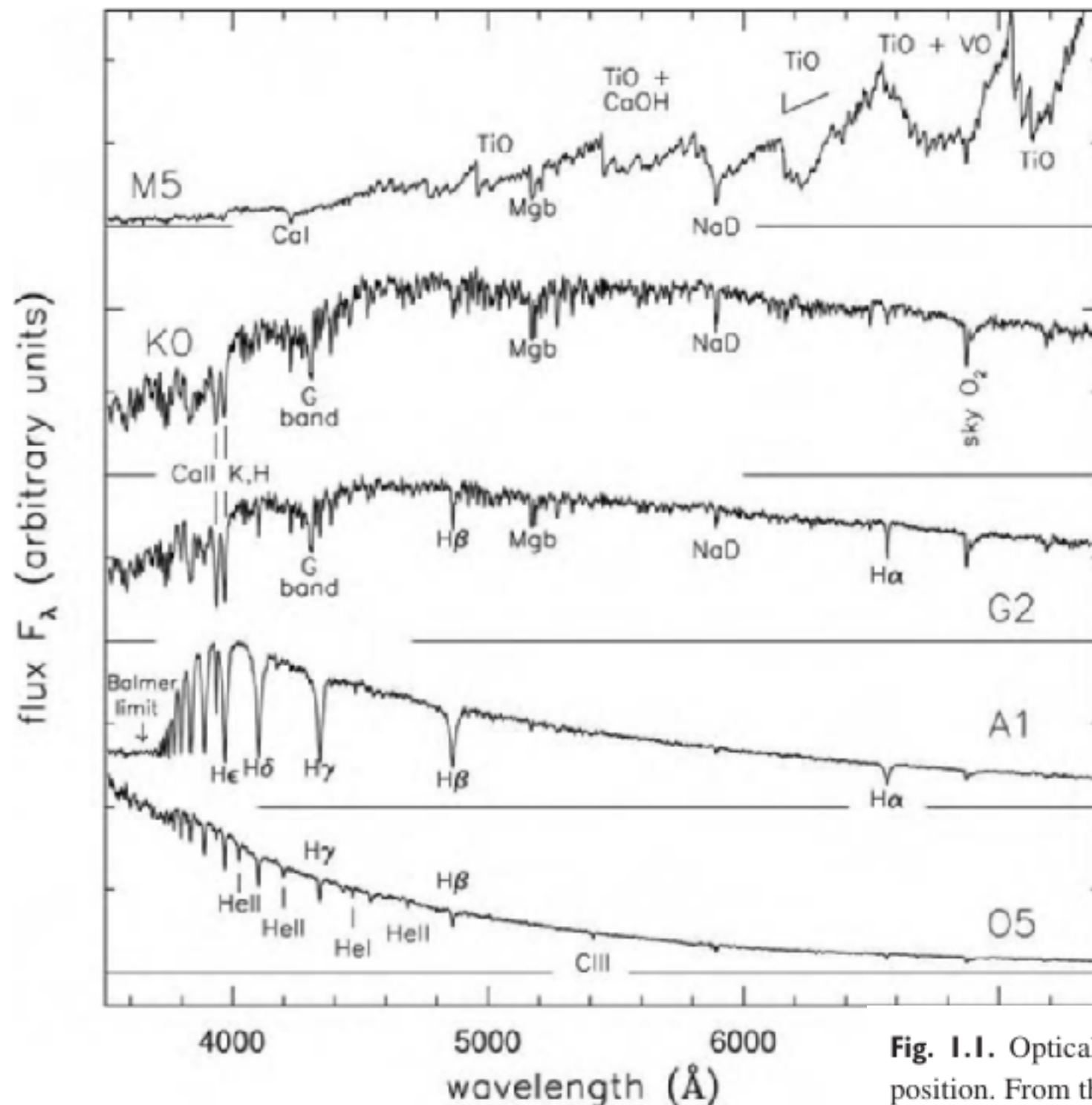
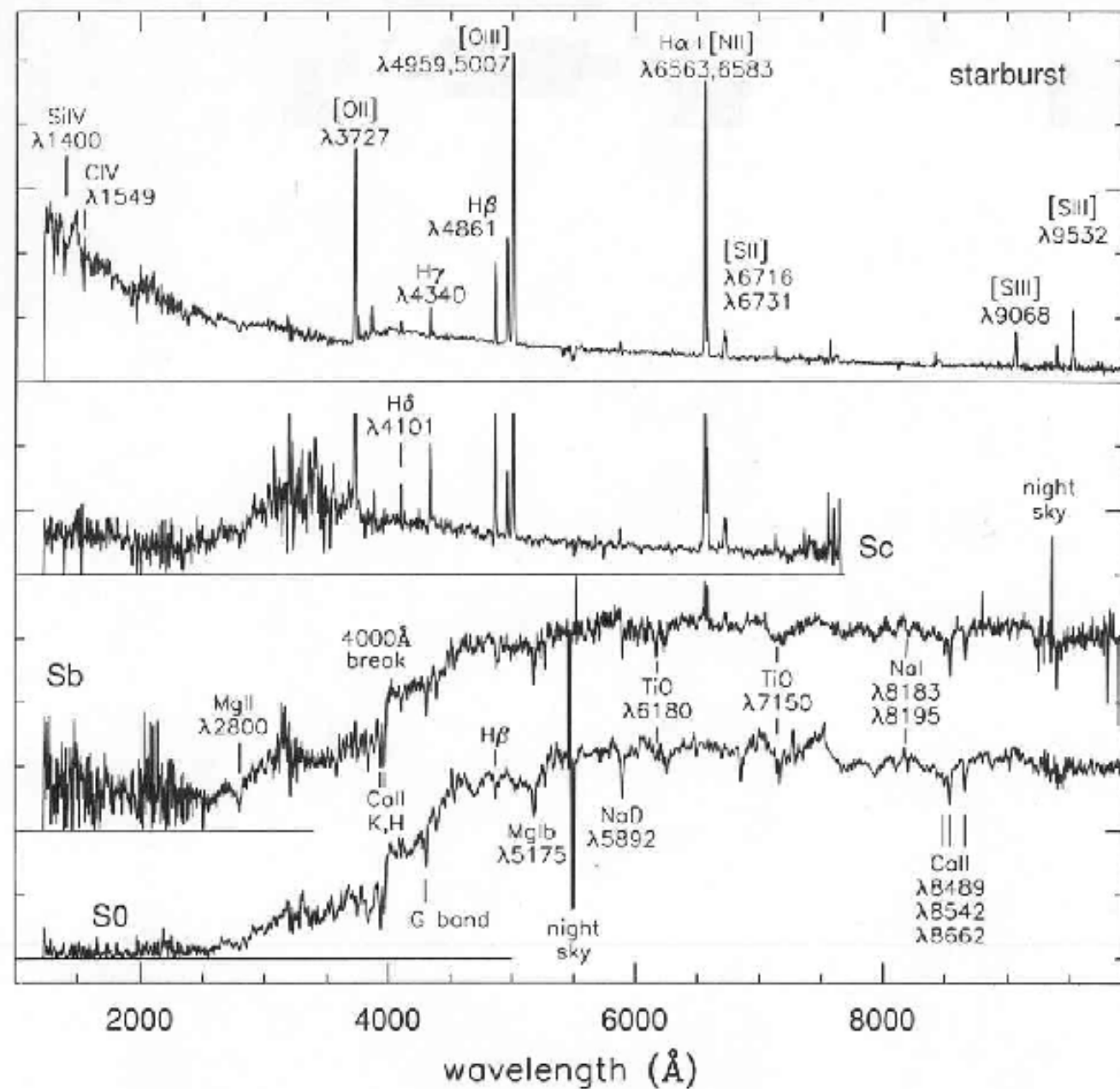
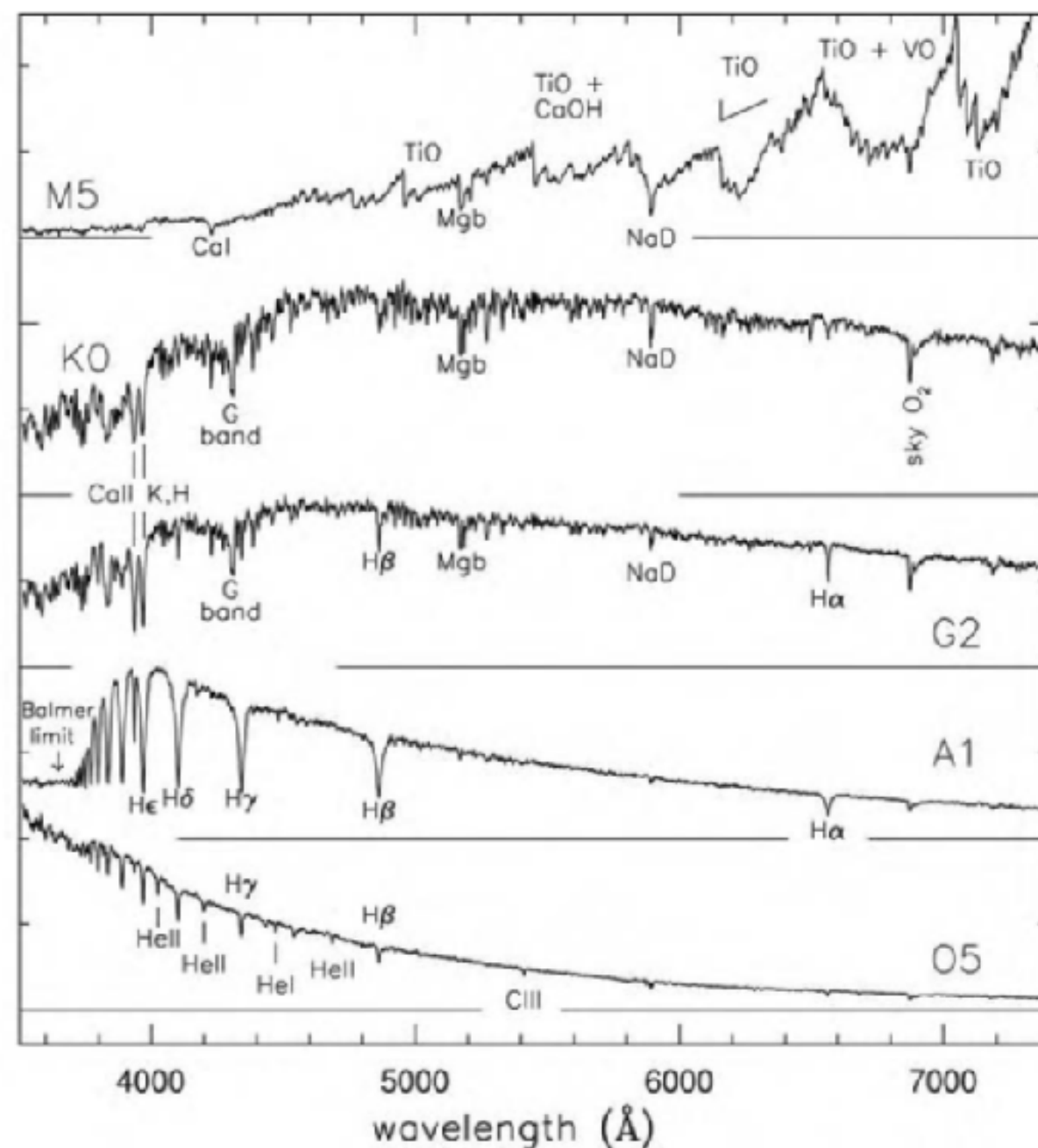


Fig. 1.1. Optical spectra of main-sequence stars with roughly the solar chemical composition. From the top in order of increasing surface temperature, the stars have spectral classes M5, K0, G2, A1, and O5 – G. Jacoby *et al.*, spectral library.

flux F_λ (arbitrary units)



flux F_λ (arbitrary units)



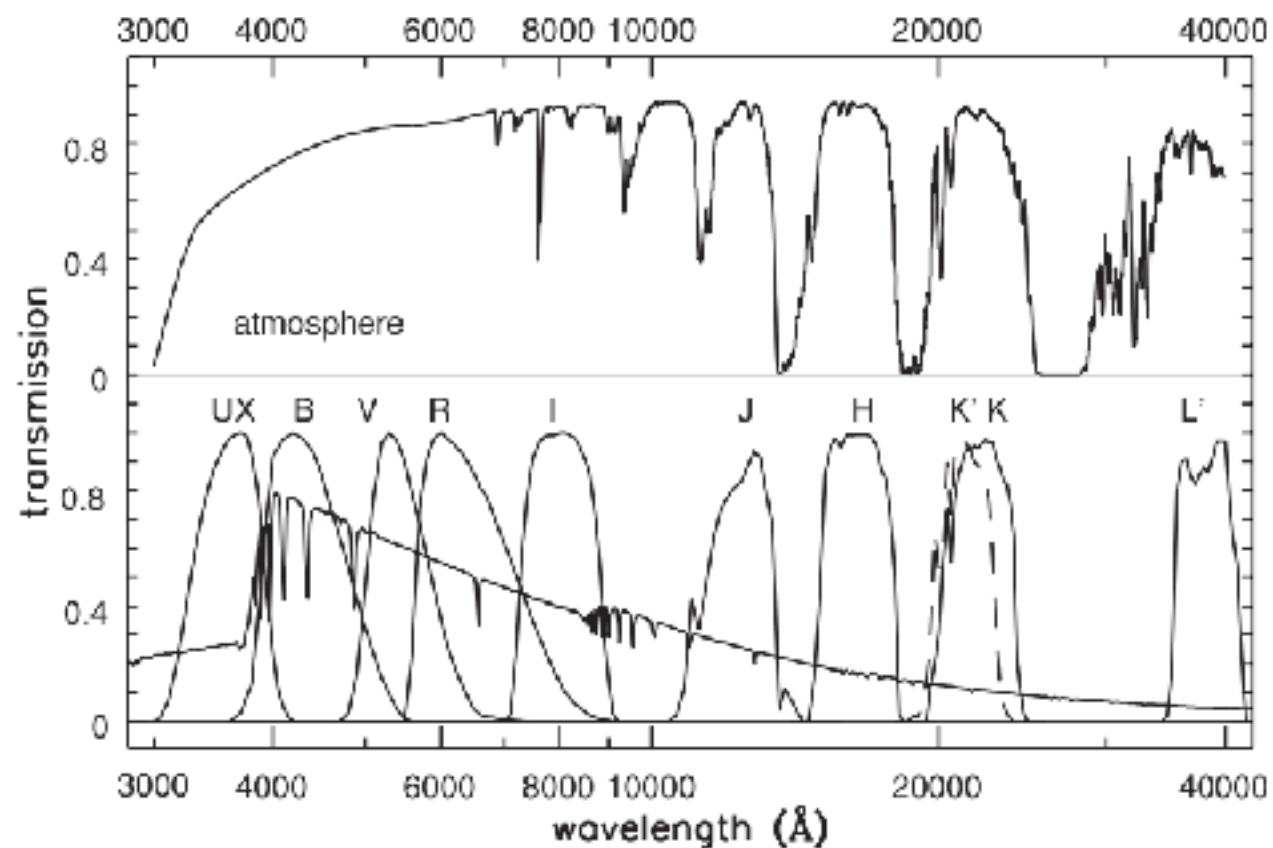


Fig. 1.7. Above, atmospheric transmission in the optical and near-infrared. Below, flux F_λ of a model A0 star, with transmission curves $T(\lambda)$ for standard filters (from Bessell 1990 *PASP* 102, 1181). UX is a version of the U filter that takes account of atmospheric absorption. For $JHK'KL'$, $T(\lambda)$ describes transmission through the atmosphere and subsequently through the filter.

$$F_{BP} \equiv \int_0^\infty T_{BP}(\lambda) F_\lambda(\lambda) d\lambda$$

$$m_{1,BP} - m_{2,BP} = -2.5 \log_{10} \left\{ \int_0^\infty T_{BP}(\lambda) F_{1,\lambda}(\lambda) d\lambda / \int_0^\infty T_{BP}(\lambda) F_{2,\lambda}(\lambda) d\lambda \right\}$$

M106: IR (vermelho), x-ray (azul), radio (violeta) e visível
(Crédito: NASA, ESA, the Hubble Heritage Team (STScI/AURA), and R. Gendler)

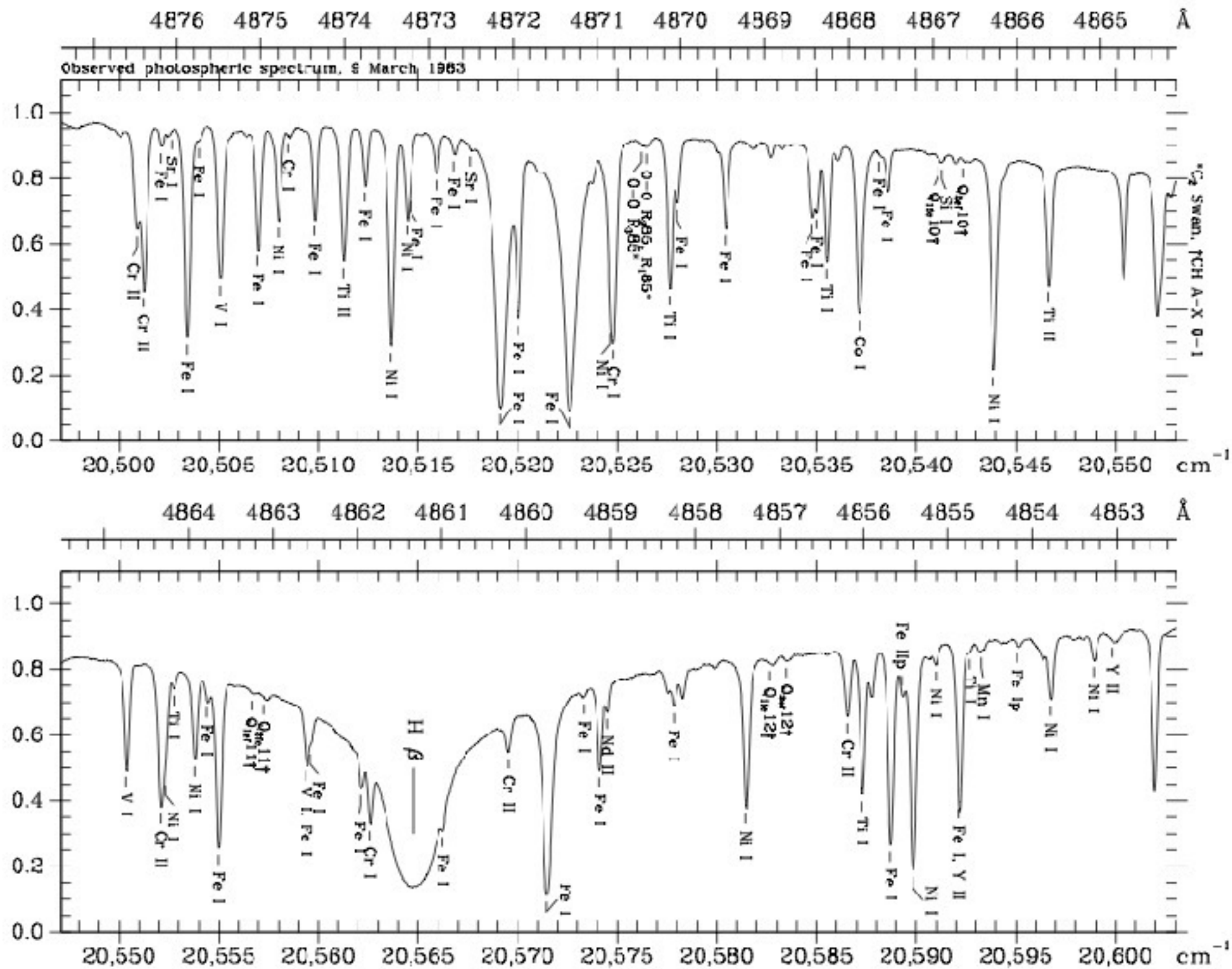


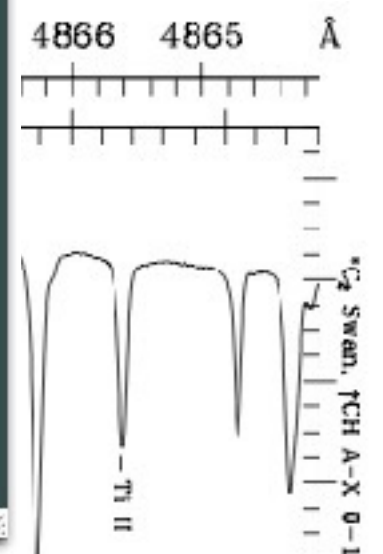
Fotometria

Não apresenta tantos detalhes quanto espectroscopia, mas pode observar ordens de magnitude mais galáxias

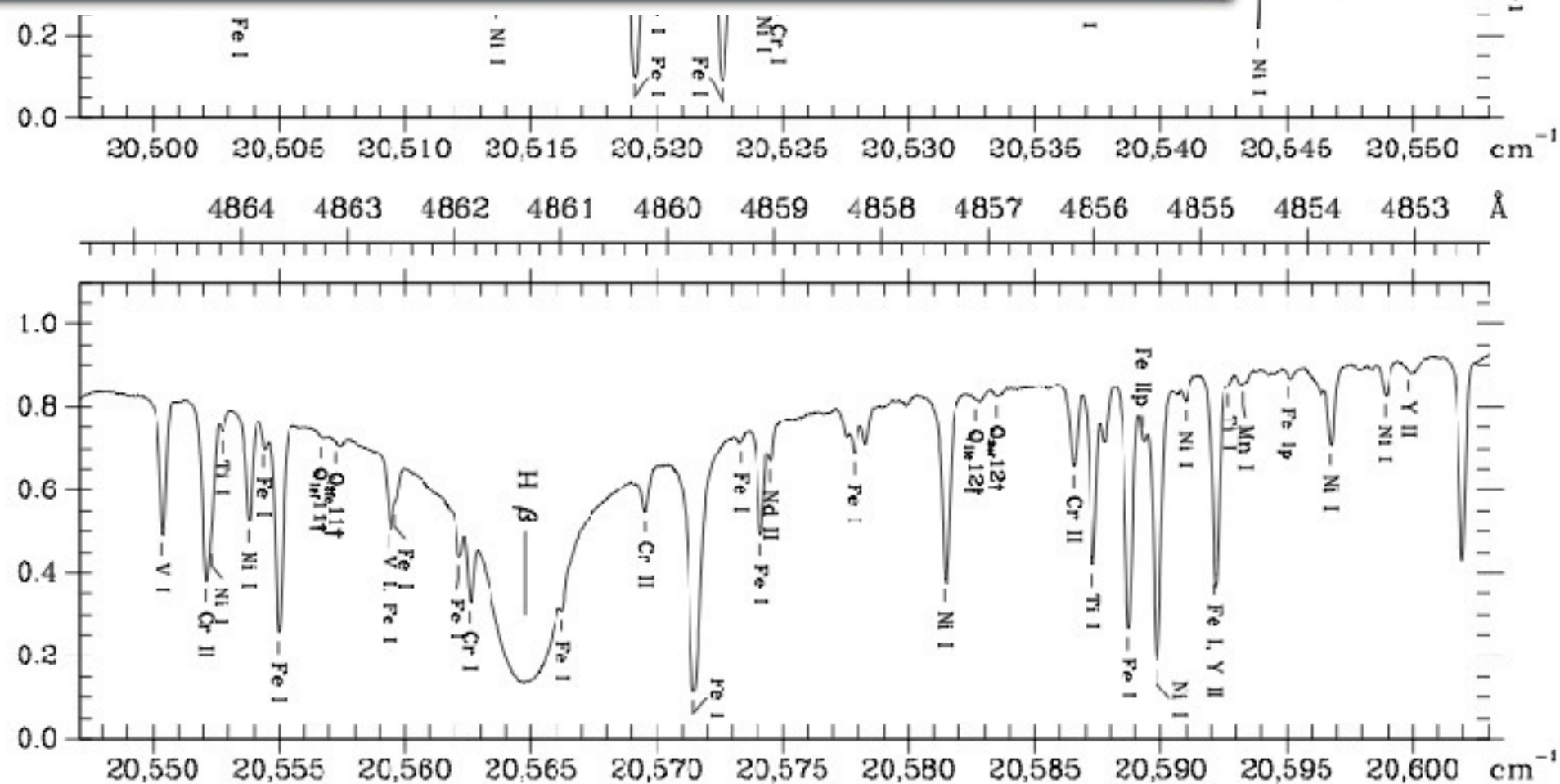
Absorption stellar spectra

$$R = \frac{\lambda}{\Delta\lambda} = \frac{c}{\Delta v}$$

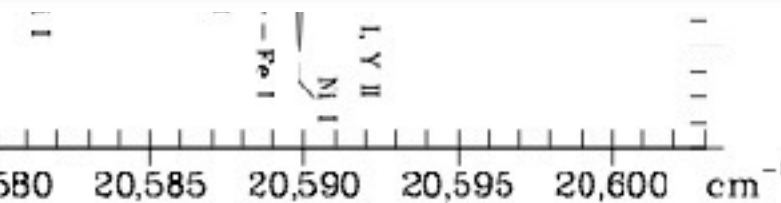
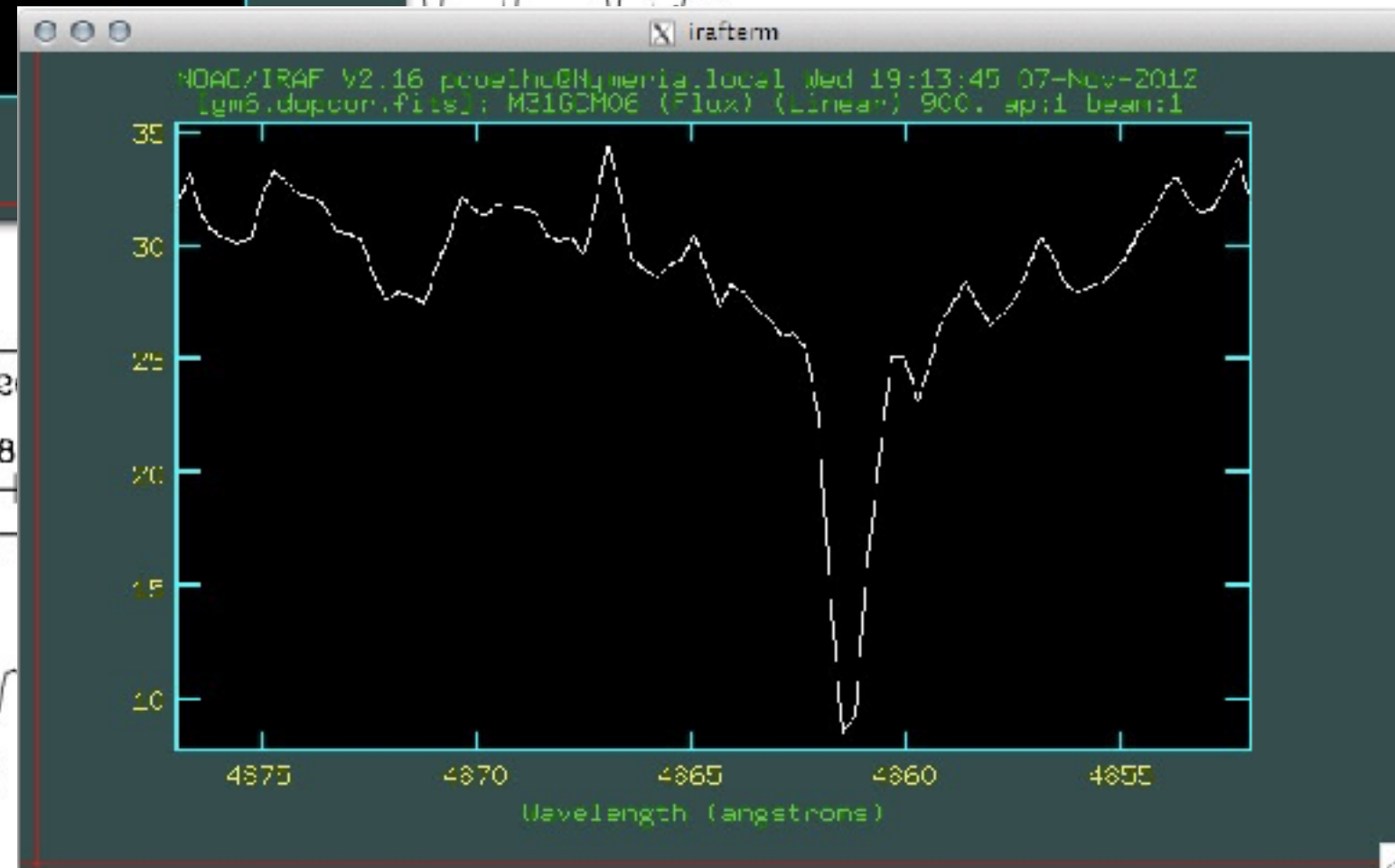
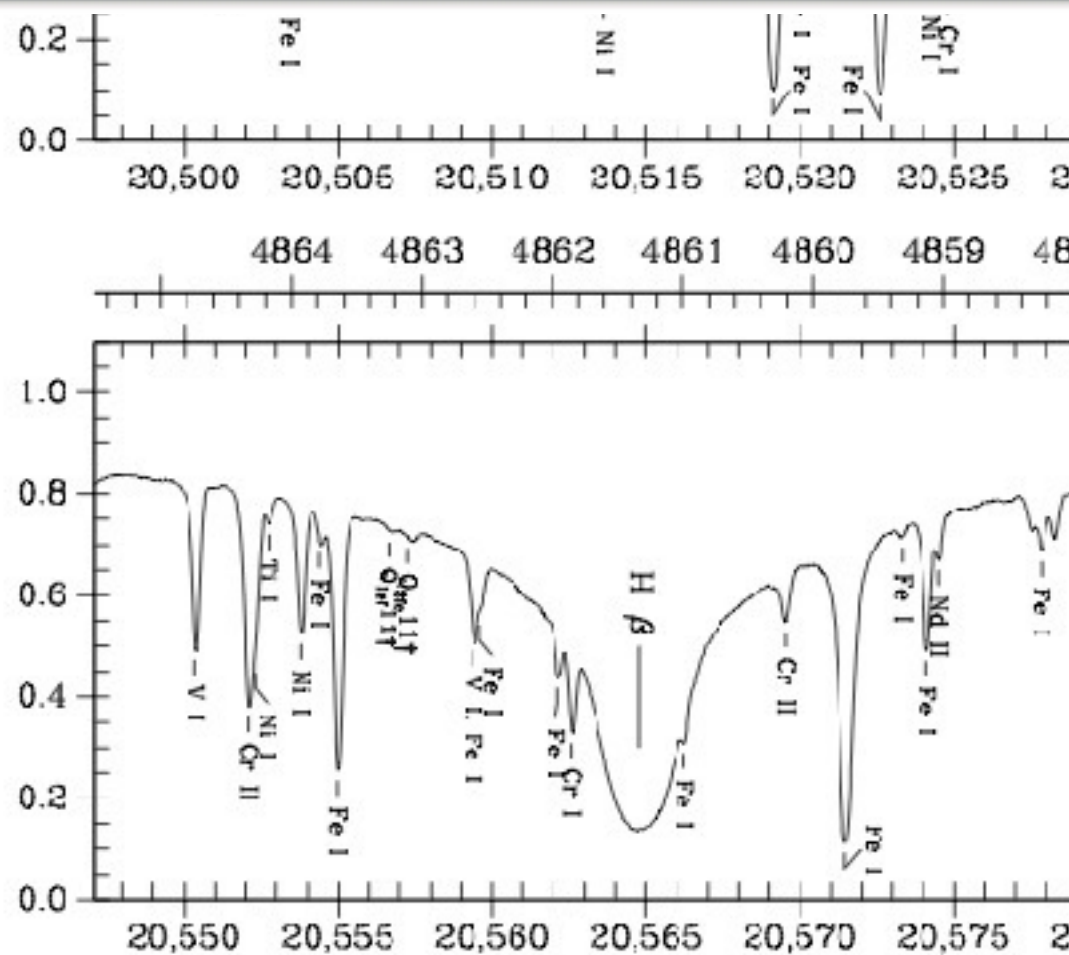
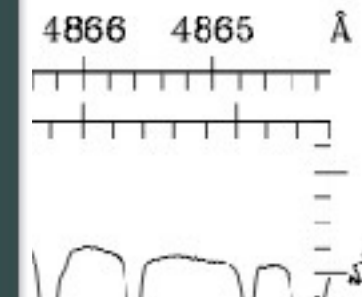
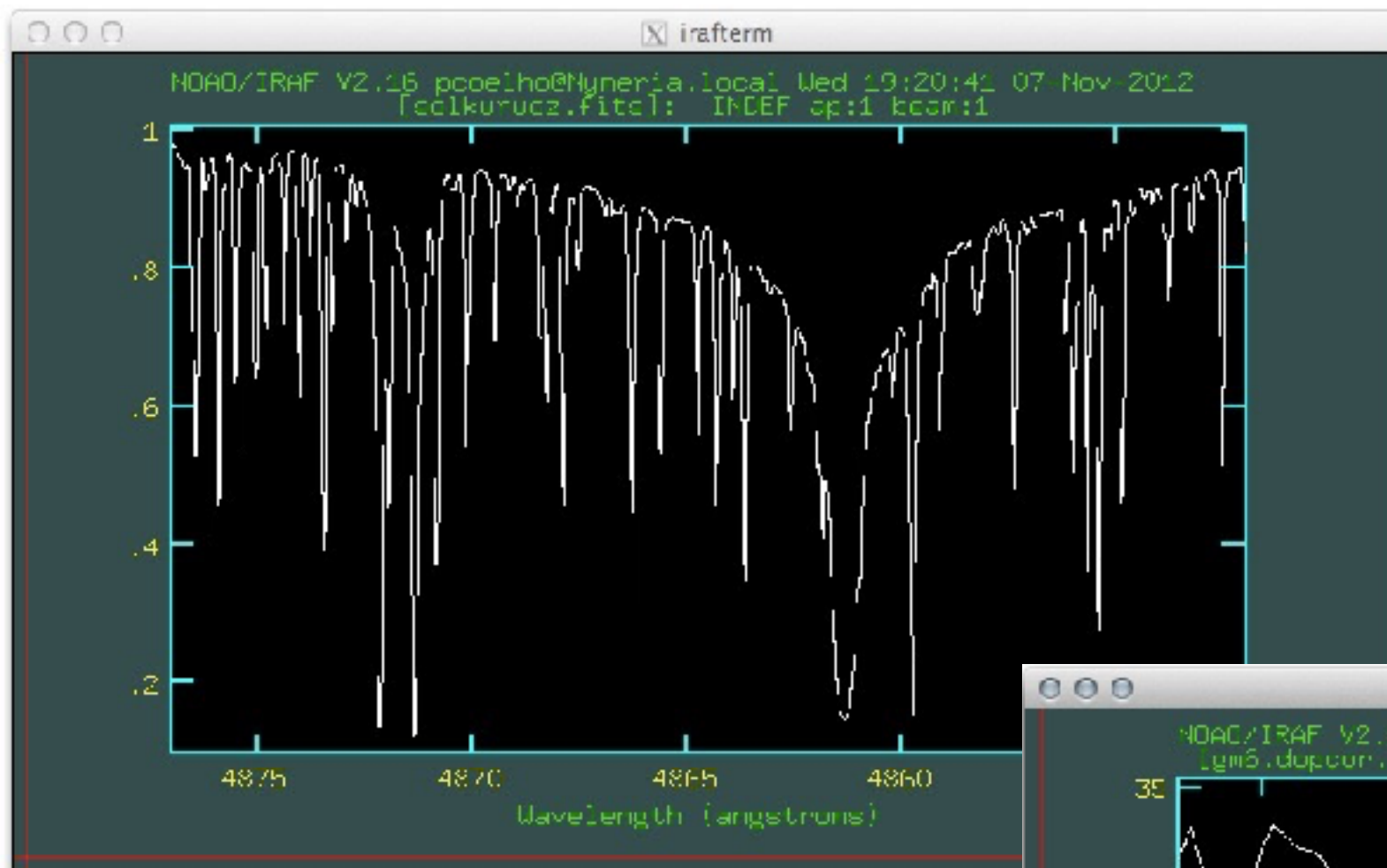




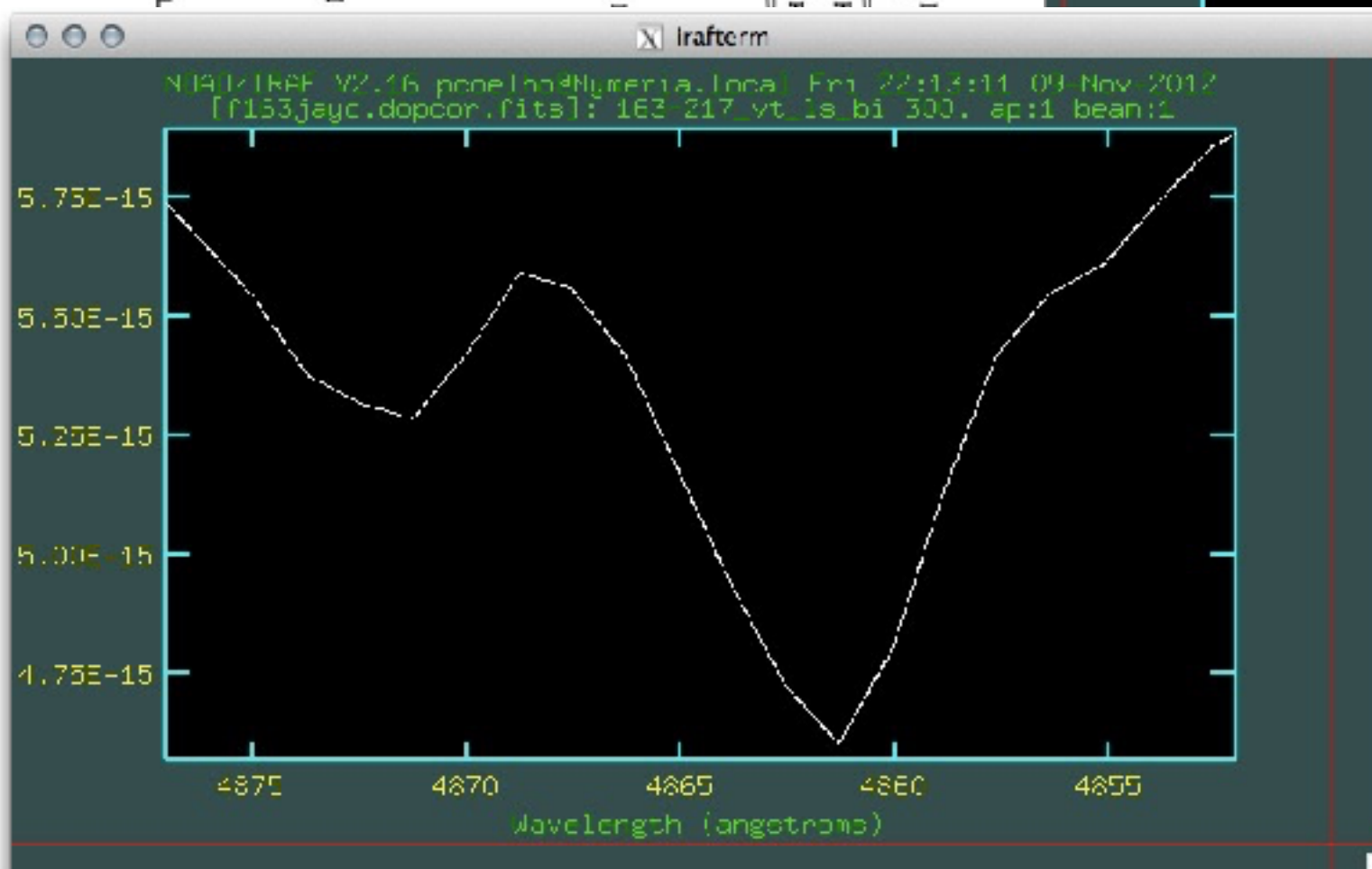
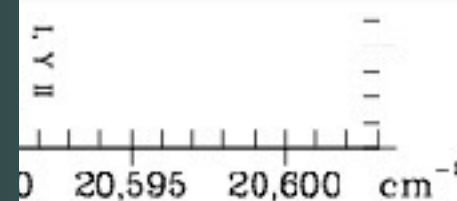
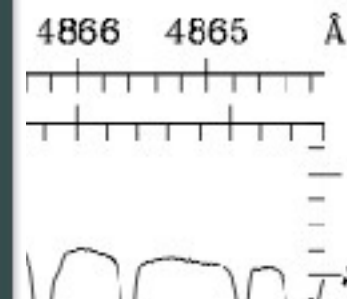
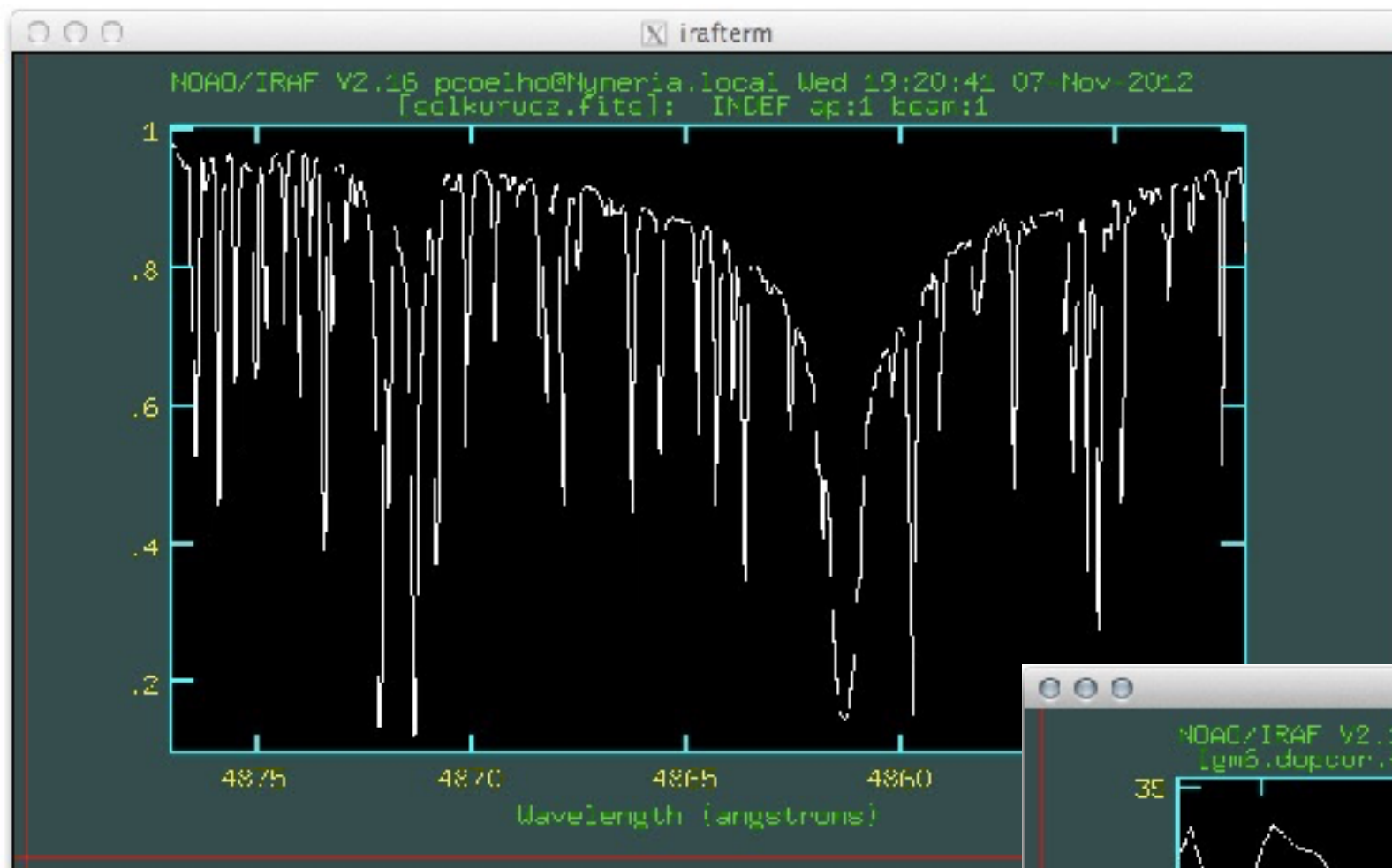
$$R = \frac{\lambda}{\Delta\lambda} = \frac{c}{\Delta v}$$



$$R = \frac{\lambda}{\Delta\lambda} = \frac{c}{\Delta\nu}$$



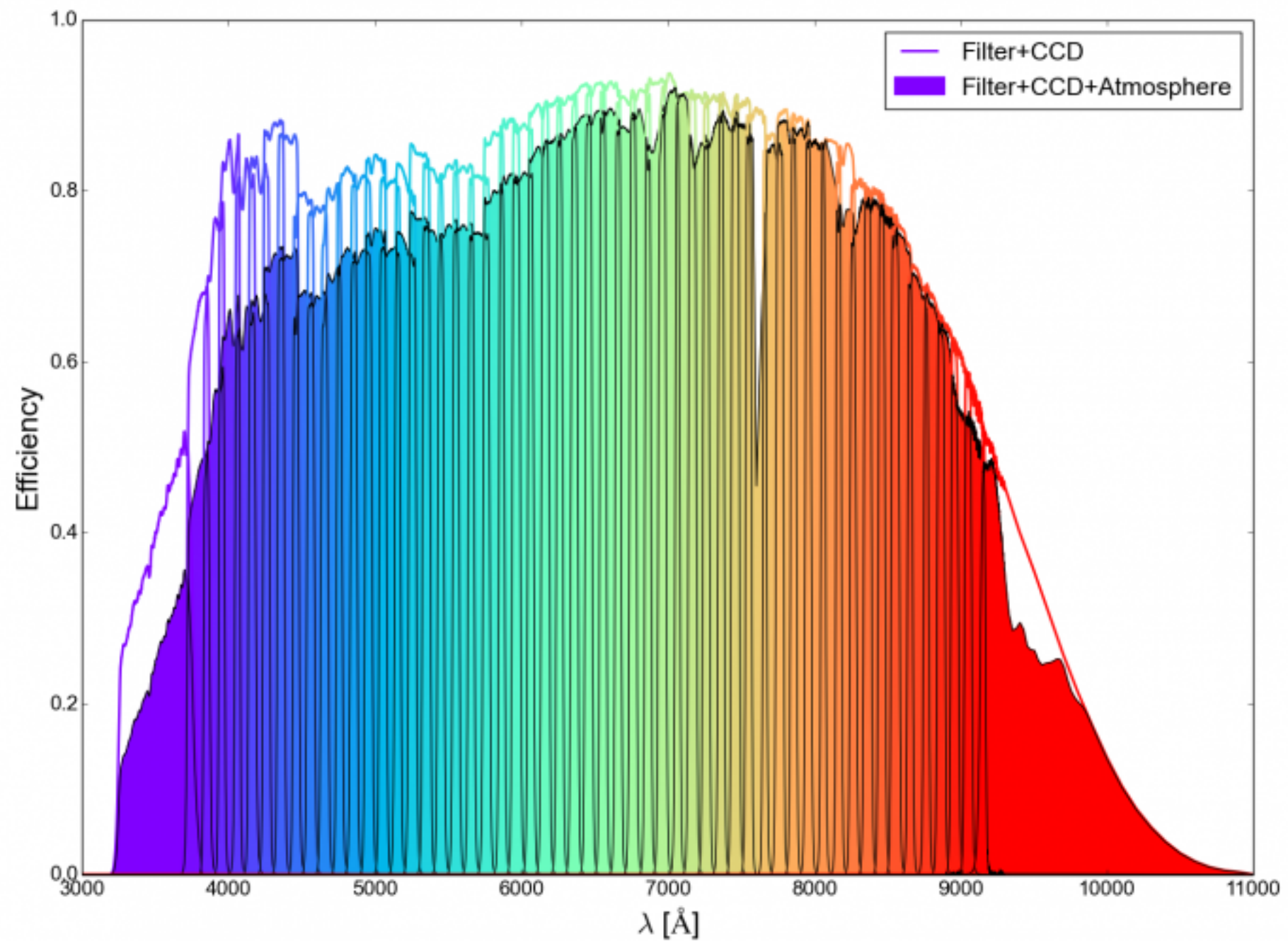
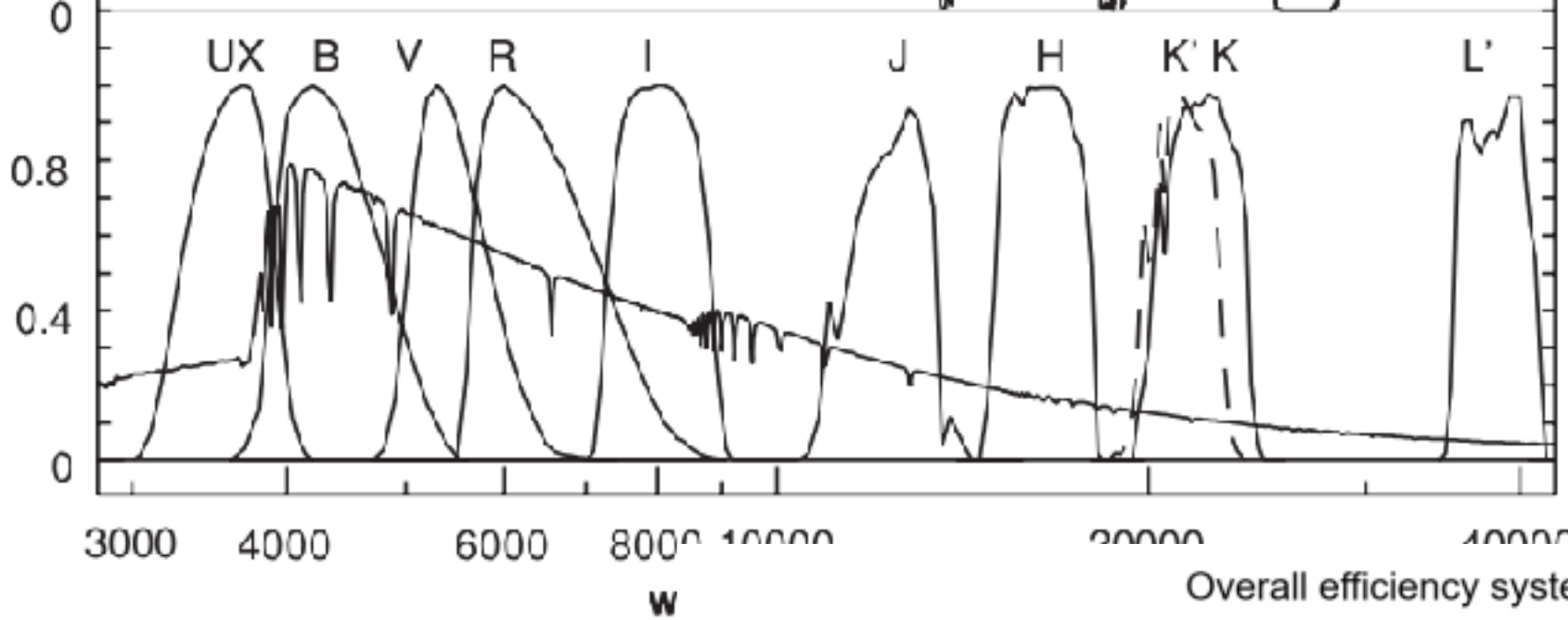
$$R = \frac{\lambda}{\Delta\lambda} = \frac{c}{\Delta\nu}$$



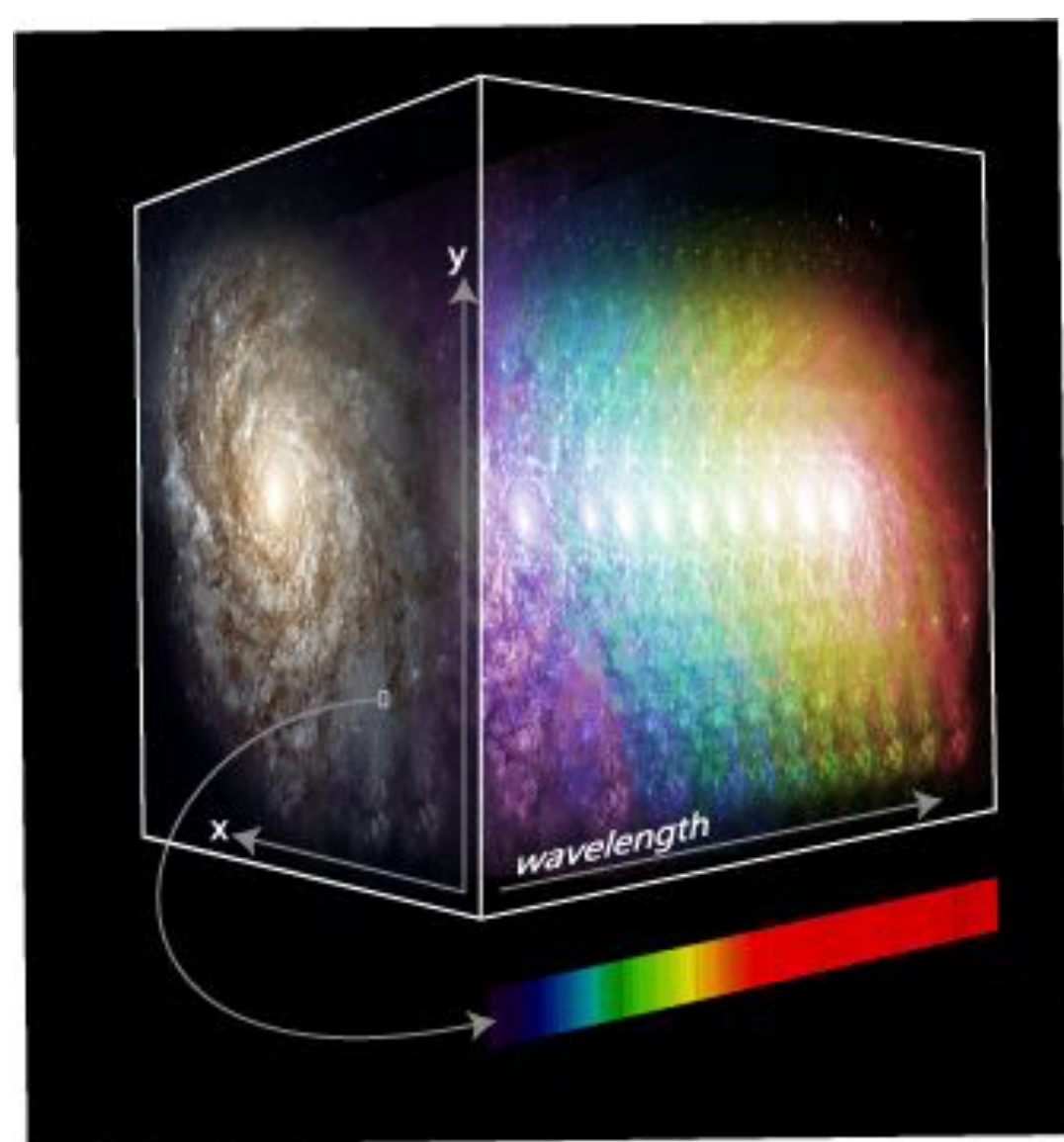
Fotometria *E* espectroscopia ?

- Meio termo entre fotometria e espectroscopia
 - Integral Field Spectrographs (cubos de dados)
 - Multispectral / Hyperspectral imaging / Quasi-spectroscopy (usado em agricultura, imagens biomédicas, geociências, física, segurança...)

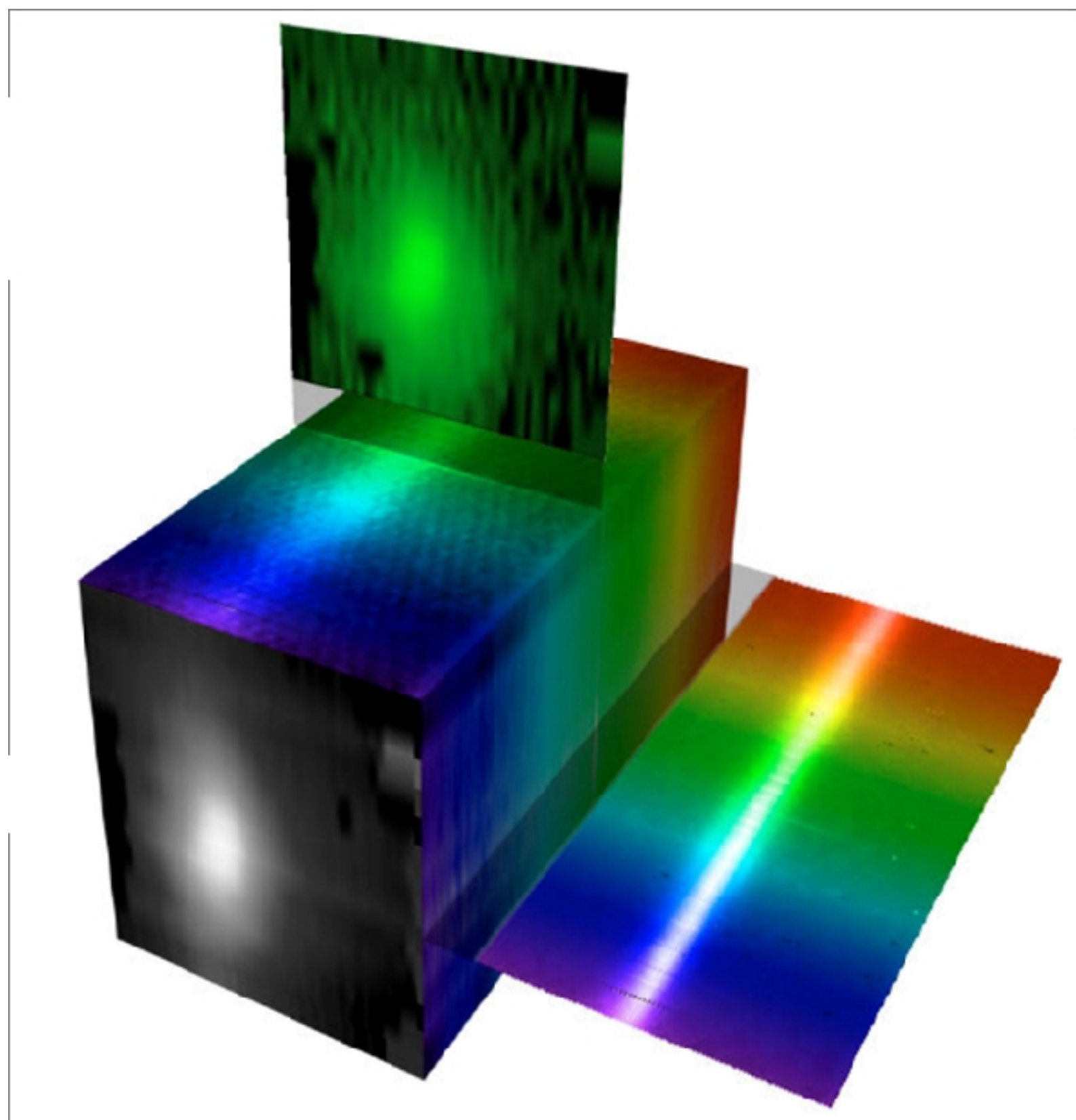
Multispectral imaging



$R \sim 50$



Data Cubes



<https://angelrls.wordpress.com/2014/10/01/dissecting-galaxies-of-the-local-universe-with-the-califa-survey/>

<http://Isiit-miv.u-strasbg.fr/paseo/cubevisualization.php>

a galaxy





a galaxy

what we think a
galaxy is



a galaxy

telescope

data reduction/
processing

observed data

what we think a
galaxy is



a galaxy

**what we think a
galaxy is**

telescope

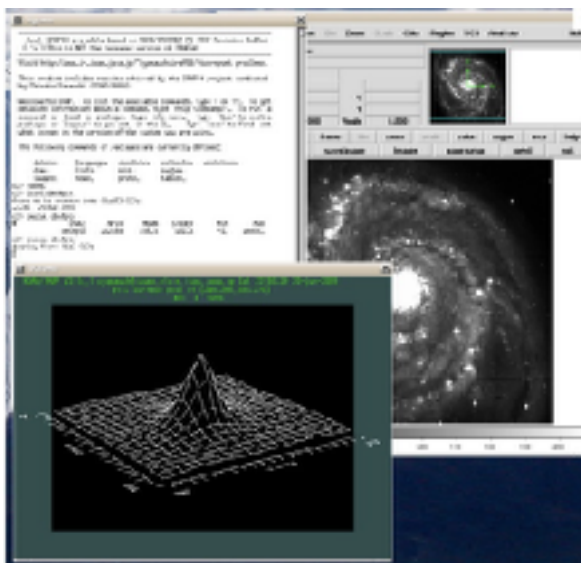
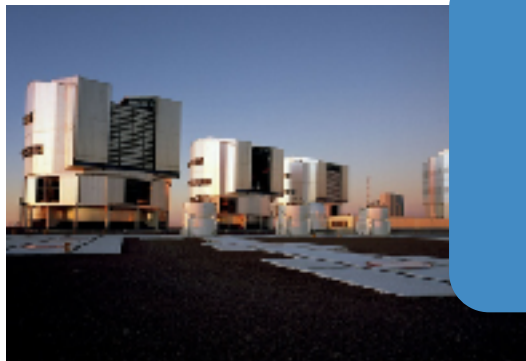
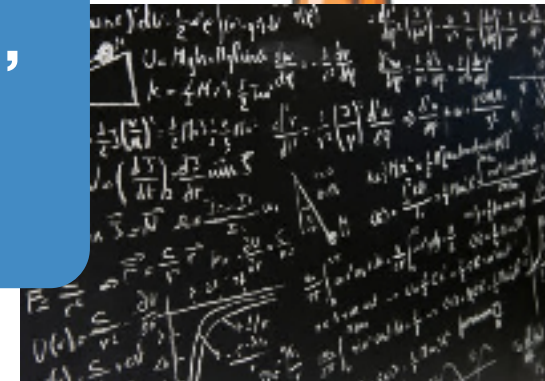
**math. model,
numerical
algorithm**

**data reduction/
processing**

**computer
simulation**

observed data

simulated data



a galaxy



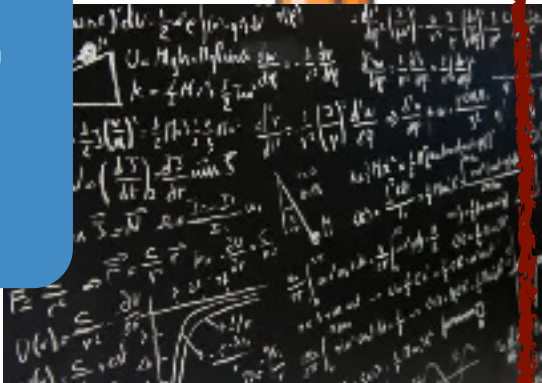
what we think a galaxy is



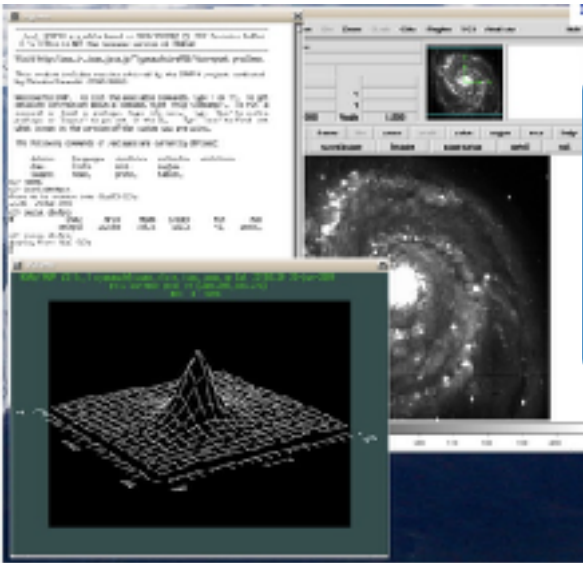
telescope



math. model,
numerical
algorithm



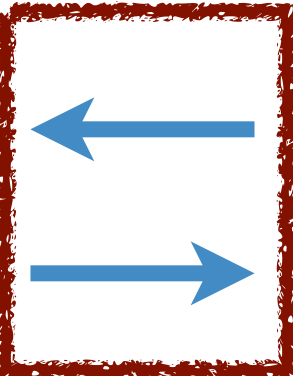
data reduction/
processing



computer
simulation



observed data



simulated data

knowledge

espectroscopia

**multi-spectral
imaging**

fotometria

IFS

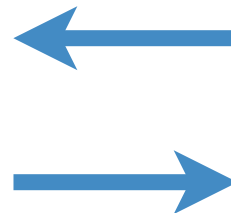
**dados
(telescópio ou
surveys, big
data)**

**modelos,
teorias físicas**

**processamento
de dados (ou
data mining)**

**simulações
computacionais**

**dados
observacionais**



**dados
simulados**

**Estatística, ciência
da computação**